

SEASONAL FOOD HABITS OF THE MARSH HAWK IN PENNSYLVANIA¹

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THROUGHOUT the course of a management study of the Ring-necked Pheasant (*Phasianus colchicus*) in Pennsylvania, considerable attention was devoted to the determination of the relationships of birds of prey to the pheasant populations. As a means of ascertaining these relationships, the food habits of several species of raptors were investigated. This paper presents the information now available from this study on the food habits of the Marsh Hawk (*Circus hudsonius*).

This research was pursued under the supervision of Dr. Logan J. Bennett, Biologist, U. S. Bureau of Biological Survey, and Dr. P. F. English, Associate Professor of Wildlife Management, Department of Zoology and Entomology, The Pennsylvania State College.

The pheasant study was conducted on a 1,675-acre sample tract in Lehigh County in southeastern Pennsylvania. The study area is in the heart of first-class pheasant range and is also situated in the most productive agricultural section of the Commonwealth.

Despite the absence of marshes or swales Marsh Hawks were common on the study area throughout the year. From late in summer until spring, they utilized weedy grain stubblefields as roosting sites. During the spring the Marsh Hawks sometimes roosted in waste areas that maintained a luxuriant growth of weeds from the previous year. Three of the four nests located during this study were in wheatfields, and the fourth was in a dense stand of reed canary grass (*Phalaris arundinacea*).

Pellets were collected weekly from the roosts. Between August 15, 1938, and September 15, 1939, a total of 598 pellets, containing 762 items of prey, were collected and analyzed. The pellets cast by Marsh Hawks are fairly good for quantitative work, especially in fall and winter. The technique described by Errington (1930, 1932) was followed in the analysis, and only bones of vertebrates and skeletal parts of insects were used in the determination of numbers of prey.

In the following discussion the material will first be presented by seasons and will then be summarized for the year.

FALL FOOD HABITS

During the fall (September, October, and November, 1938) the diet of the Marsh Hawks ran largely to mice (Table 1). Birds were of some importance as food, making up 18.4 per cent of the fall food items.

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The only game bird taken during these months was an immature Ring-necked Pheasant, occurring in an early September pellet. Smaller birds identified in the fall pellets included 15 Flickers (*Colaptes auratus*), 2 Song Sparrows (*Melospiza melodia*), and 2 Starlings (*Sturnus vulgaris*).

It is conceivable that the common skunk (*Mephitis nigra*) and the domestic cat (*Felis domestica*) in the fall pellets may have been carrion, for a relatively weak-clawed raptor like the Marsh Hawk would certainly have considerable trouble in capturing and killing adults of these species.

WINTER FOOD HABITS

As the weather became colder, mice became even more important as a Marsh Hawk food; birds were only infrequently represented in the pellets (Table 1). No game birds occurred in the winter (December, 1938, to March, 1939) pellets. Small birds included 5 Song Sparrows, 2 Tree Sparrows (*Spizella arborea*), and 1 Junco (*Junco hyemalis*). Seven songbirds were not identified.

Cottontails (*Sylvilagus* spp.) seemed to be the only game species eaten by the hawks during the winter. Remains of these animals were found in nine pellets and represented 4.7 per cent of the winter prey.

The winter diet of the Marsh Hawk was greatly influenced by the weather (Randall, 1939). A period of deep snow made mice difficult to obtain. The hawks were then forced to depend to a larger extent on cottontails and small birds for food. It was interesting to note that five of the nine cottontails represented in the winter pellets were taken during a 10-day period when the snow was more than a foot deep.

SPRING FOOD HABITS

With the coming of spring, the emergence of certain mammals from hibernation and the northward migration of hordes of small birds made food easier for the Marsh Hawks to obtain. Although the spring (April and May, 1939) data are fewer than those for the other seasons, they indicate that birds again became an important Marsh Hawk food at this season of the year. Avian prey in the spring pellets included 1 Rock Dove (*Columba livia*), 16 Flickers, 4 Starlings, 1 Red-wing (*Agelaius phoeniceus*), and 8 unidentified small birds.

Despite the increase of birds in the hawk's diet, mice were the most important source of food. The spring foods are also summarized in Table 1.

SUMMER FOOD HABITS

In the summer of 1939 a great variety of prey was available to the raptors. Easily captured juveniles, both avian and mammalian, abounded. Reptiles and amphibians were also numerous and could easily be obtained by an alert hawk.

TABLE 1
SEASONAL FOODS OF THE MARSH HAWK, 1938-39

Season of year Number of pellets examined	Fall 177		Winter 156		Spring 80		Summer 185	
Kind of prey	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Mice (<i>Microtus</i> spp., <i>Peromyscus</i> spp., <i>Pitymys</i> sp., and <i>Zapus</i> spp.)	179	76.5	159	83.7	46	52.9	99	39.6
Shrews (<i>Sorex</i> sp. and <i>Blarina</i> sp.)	2	0.8	1	0.5	2	2.3	4	1.6
Chipmunks (<i>Tamias striatus</i>)	...	...	...	...	3	3.4	2	0.8
Red squirrel (<i>Sciurus hudsonicus</i>)	1	0.4	...	...	...	...	...	...
Cottontails (<i>Sylvilagus</i> spp.)	4	1.7	9	4.7	4	4.6	21	8.4
Skunks (<i>Mephitis nigra</i>)	1	0.4	...	...	...	...	1	0.4
House cat (<i>Felis domestica</i>)	1	0.4	...	...	...	...	...	...
Weasel (<i>Mustela</i> sp.)	1	0.4	3	1.6	...	...	...	...
Muskrat (<i>Ondatra zibethica</i>)	...	...	1	0.5	...	...	...	...
Unidentified mammals	1	0.4	1	0.5	...	...	...	...
Ring-necked Pheasants (<i>Phasianus colchicus</i>)	1	0.4	...	...	...	...	6	2.4
Mourning Doves (<i>Zenaidura macroura</i>)	...	...	...	...	...	...	4	1.6
Picidae (mostly Flickers)	15	6.4	...	...	16	17.8	31	12.4
Other birds (mostly passerines)	27	11.6	15	7.9	14	16.7	66	26.4
Domestic fowl	...	...	...	...	...	...	2	0.8
Snakes (<i>Thamnophis</i> spp.)	1	0.4	...	...	2	2.3	6	2.4
Frogs (<i>Rana</i> sp.)	...	...	1	0.5	...	...	8	3.2
Insects	...	...	trace	trace	trace	trace	trace	trace
TOTALS	234	99.8	190	99.9	87	100.0	250	100.0

(a) Number of individuals.
(b) Percent of total.

Despite the abundance of other prey, mice were the most important food of the hawks (Table 1). These rodents were eaten most extensively late in summer after the harvest. The standing grain early in summer protected the mice and made them difficult for the hawks to obtain.

Early in summer (June and early in July, 1939) juvenile birds were the most important food of the hawks. The new-mown hayfields were an excellent hunting ground. Many Eastern Meadowlark (*Sturnella magna*), Redwing, Bobolink (*Dolichonyx oryzivorus*), and Field Sparrow (*Spizella pusilla*) nests were on the ground or on the weeds in the hay. After the mowing these nests lay on the ground with the young exposed to the elements and to any predator that happened along. Marsh Hawks were apparently aware of this easy source of food, for they were frequently observed cruising over recently mown hayfields. A large proportion of the young ground-nesting passerine birds in the summer food items were secured in this manner.

To obtain as many quantitative data as possible on the early summer food habits, juvenile Marsh Hawks were tethered at the nests in the manner described by Errington (1932). Three young hawks were held captive and fed by the parents for several weeks after they would ordinarily have been fending for themselves. The gullets of the juveniles were emptied daily or twice daily by squeezing, and the contents were analyzed. Sixty-one gullet collections were obtained by this method. After the gullets were robbed, the young hawks were sometimes forced natural foods so that they would not suffer from a lack of proper nourishment.

The foods brought to the nest are listed in Table 2. These data were procured between June 20 and July 23. Juvenile birds of ground-nesting passerines were the most important items of food.

TABLE 2
FOODS BROUGHT TO THE NEST, 1939

Kind of prey	Number of individuals	Per cent of total
Mice (<i>Microtus</i> spp.)	14	20.9
Young cottontails	7	10.4
Young Ring-necked Pheasants	2	3.0
Young Mourning Doves	2	3.0
Flickers	5	7.5
Young Killdeer	2	3.0
Young passerine birds (Meadowlarks, Redwings, Bobolinks, Robins, Sparrows, and Grackles)	30	44.9
Domestic chickens	2	3.0
Frogs	2	3.0
Garter snake	1	1.5
TOTAL	67	100.2

Representatives of game species found among the summer foods (specimens brought to the nest and items found in pellets) included 8

Ring-necked Pheasants, 6 Mourning Doves (*Zenaidura macroura*), and 28 cottonails. Most of these were juveniles.

Other miscellaneous summer foods included shrews, chipmunks, snakes, frogs, and insects. The reptiles, amphibians, and invertebrates were most numerous in the late summer pellets.

Late in summer the parent hawks gradually ceased feeding their offspring, and the latter learned to hunt for themselves. The young had considerable difficulty in obtaining enough to eat when they began to hunt for themselves. Although no quantitative data are available on the food habits of the young after leaving the nest, observations indicate that they fed on fresh carrion, insects, snakes, and other slow-moving prey. Errington and Breckenridge (1936) reached somewhat similar conclusions regarding the food habits of juveniles during their first weeks of hunting.

English (1933) related an instance in which young Marsh Hawks, forced by circumstances to begin hunting unusually early in life, became serious predators of pheasants and had to be killed. He believed this to be an unusual case, however, rather than a normal one.

RELATION TO GAME AND ECONOMIC STATUS

As a prelude to discussion of the economic status of the Marsh Hawk in the Pennsylvania pheasant range, the foods for the year were totaled in Table 3. There was a slight preponderance of data from the summer season and a smaller amount of spring data. This condition tended to overemphasize the importance of birds in the yearly diet, as summer was the time when most of the avian prey was taken.

Nine Ring-necked Pheasants, apparently all juveniles, were taken by Marsh Hawks on the study area during the summer. The pheasant

TABLE 3
FOODS FOR THE YEAR, 1938-39

Kind of prey	Number of individuals	Per cent of total
Mice	500	60.3
Shrews	9	1.1
Cottontails	45	5.4
Chipmunks	5	0.6
Red squirrel	1	0.1
Weasels	4	0.5
Skunks	2	0.2
Muskrat	1	0.1
House cat	1	0.1
Unidentified mammals	2	0.2
Domestic fowl	4	0.5
Ring-necked Pheasants	9	1.1
Mourning Doves	6	0.7
Flickers	66	8.0
Other birds (mostly small passerines)	154	18.6
Frogs	11	1.4
Garter snakes	9	1.1
TOTAL	829	100.0

population studies revealed that 776 young Ring-necked Pheasants were hatched on the study area during the summer of 1939. Although the nine young birds captured by Marsh Hawks represented 9.4 per cent of the juvenile mortality, they made up only 1.2 per cent of the juvenile population. This was a very slight loss and was of particular interest because of the high pheasant population maintained on the study area. The sample tract supported in fall a pheasant density of about one bird to 2 acres.

Errington and Hamerstrom (1937) reported that pheasant broods in areas heavily hunted by Marsh Hawks shrank in size at the same rate as did broods in areas where these hawks were rare. They found no perceptible relation between the conspicuous preying of local Marsh Hawks and the seasonal shrinkage in the size of pheasant broods. Apparently mortality from other causes occurred when Marsh Hawks were absent.

Neither pellet analyses nor careful field observations revealed any depredations on adult pheasants by Marsh Hawks. Adult Ring-necked Pheasants exhibited little fear of this species of hawk. It was not uncommon for a flock of pheasants in the open to feed unconcernedly while a Marsh Hawk flew past a few feet overhead.

Remains of four young Mourning Doves were found in adult summer pellets, and two others were fed to nestlings. In view of the large nesting population of doves on the area, this was a comparatively small loss. At least 40 pairs of doves—probably many more—nested on the study tract. As a rule, Mourning Dove nests were too well concealed from above for the nestlings to be discovered by Marsh Hawks.

Traces of cottontails appeared 45 times in the yearly diet of the hawks, but 28 of these were taken during the summer. Some of the rabbits were probably eaten as carrion. Marsh Hawks were frequently observed feeding on the carcasses of rabbits killed by automobiles. The victims of haying or harvesting were another source of carrion cottontails utilized by the hawks. Many cottontails, especially juveniles, were struck and killed by the mowing-machines or grain binders. On one occasion a Marsh Hawk was seen carrying the carcass of a half-grown rabbit that had been killed by a binder. Unfortunately, it was impossible to determine how many of the cottontails eaten by the hawks represented carrion. Even if all the rabbits occurring in the pellets were considered kills (which they certainly were not), the Marsh Hawk could hardly be thought a limiting factor on the cottontail population of the study area. Although cover was sparse in parts of the study tract, a good cottontail population persisted. The kill by hunters in the fall of 1938 was about one rabbit to 5 acres, and an adequate breeding stock was left.

When determining the economic status of the Marsh Hawk, one must recall that a large part of the avian prey listed in Table 3 was pro-

cured by the hawks as carrion or after the young birds had been exposed by the activities of man.

Among the birds, only the Flicker seemed to have a steady place in the Marsh Hawks' diet. This woodpecker was taken during all seasons except winter and represented 8 per cent of the yearly food. The Flicker, a relatively slow flyer and often found in the open, probably was an easy prey for the hawks. This preying upon Flickers causes some economic loss, as their general food habits are quite beneficial to man (Beal, 1911).

Mice were the staple food of the hawks in all months of the year except June and July. More than 60 per cent of the total yearly food items consisted of these animals. These rodents are injurious to crops, and the destruction of these mice is a decided benefit to man. Other so-called destructive mammals in the hawks' diet included chipmunks, red squirrels, and weasels.

The general food habits studies by Fisher (1893) and McAtee (1935), based on stomachs collected throughout the year from all parts of the United States, indicated that mice and other injurious rodents were staple Marsh Hawk foods. In both studies more than 40 per cent of the stomachs contained the remains of one or more rodents. Stoddard (1931) found the skeletal parts of cotton rats (*Sigmodon hispidus*) in 925 of the 1,098 pellets examined from roosts on Marsh Hawk wintering grounds in Leon County, Florida. Cotton rats were serious competitors of quail for food and destroyers of quail eggs, and Stoddard concluded that by destroying these rats the Marsh Hawks were important benefactors of the Bob-white in that region.

SUMMARY

Mice formed the staple food of the Marsh Hawk during 10 months of the year. During June and July juvenile birds were the most important items of food. Many young birds were easily obtained at this season because of their exposure by mowing and harvesting.

The effect of Marsh Hawks upon the pheasant population was negligible. There was no reason to believe that the hawks were a limiting factor on the other game species on the study area.

The general food habits of the Marsh Hawk are beneficial to man, and this hawk is a decided asset to an agricultural community.

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BIBLIOGRAPHY OF CALIFORNIA ORNITHOLOGY. THIRD INSTALLMENT. TO END OF 1938. By Joseph Grinnell. Pacific Coast Avifauna No. 26. Dec. 8, 1939. (235 pp.). \$4.00.

As Joseph Grinnell himself once said, "It is only through the laborious activities of indexers and bibliographers that the working ornithologist can gain access to, and keep track of, the huge literature in his field." In this important branch of ornithological work Dr. Grinnell was long a leader, and with the publication of this volume he had completed the gigantic task of recording 6,840 scientific references to California birds which appeared in print before 1939. The thoroughness of his search can be attested by all ornithologists who have used his earlier volumes of bibliography. They know how rare it is to find an over-looked title.

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We are not yet wholly convinced that a chronological grouping of titles is the best possible arrangement of such a bibliography but, perhaps, once begun it must be continued. The format of this volume follows that of the earlier ones, including the rather extravagant spacing of titles on the page and the inconvenient and space-consuming use of Roman numerals for volume numbers.

This is not just another reference work to be filed away for possible use; it is a book to be *read* by all serious ornithologists. It brings to us a sharp realization of how much we are going to miss Joseph Grinnell.—J. VAN TYNE.